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ABSTRACT

Arranged into four parts, the paper discusses the importance of international and institutional cooperation and the appropriate use of technology in the search for new and renewable energy sources. The first part of the paper discusses the inevitable depletion of the world's oil supply, the increasing interdependency of nations, the implications of a transition from oil to other energy forms, the importance of preventing ecological imbalances, and the need for global cooperation in implementing sound energy policies. The second part of the paper deals with four international institutions that promote cooperation in energy planning. The objectives of the 1981 United Nations Conference on New and Renewable Sources of Energy are detailed and the basic goals of the Nairobi Plan of Action are listed. The third part suggests that the answer to energy needs is appropriate technology. Further, it is suggested that a combination of traditional and modern technologies seems to be a viable energy option in developing nations. Discussed is wind energy, biogasification, forestry conservation, solar power, and nuclear energy. In part 4, the paper concludes that improvements in the energy output and efficiency of third world nations can occur through a willingness by developed nations to provide assistance, and presents two basic viewpoints regarding international cooperation and aid to the third world. In addition, two tables presenting energy cooperation projects of 22 organizations in the United Nations System are provided. (LH)

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INTERNATIONAL COOPERATION IN ENERGY POLICY: IMPACTS ON DEVELOPMENT IN THIRD WORLD NATIONS

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I. The Importance of Cooperation

The world's energy situation today is as varied as there are nations on earth. To some there is plenty of energy available now and for the foreseeable future. A much larger portion of the nations of the world have energy needs that are at alarming and critical levels compared to those energy levels they are capable of producing. These nations are in an energy crisis now. For many other nations, it may be a matter of a few years or many before an energy crisis is felt. One fact is certain; the present rate of world oil consumption is much greater than that being replaced by nature. The rate of energy consumption by the people of the world has increased dramatically as nations have industrialized. A large portion of the energy production of the world is derived from fossil fuels, especially and specifically oil. The world's oil supply has a finite limit and man's use of it is almost limitless as the populations of nations and the demands for energy increase. Any pragmatic view of the continuing growth of energy needs has to conclude an eventual depletion of the world's oil supply. It is not the attempt of the authors to predict or attempt to suggest a date of this occurence. Too many factors are variable for anyone to even attempt a guess. This finite quantity and eventual depletion of oil is a major factor in determining the degree of cooperation between

nations.

The importance of cooperation in the search for new or renewable energy throughout the world is slowly, too slowly, becoming evident to many industrially developed and less developed countries. The interdependency of nations has been made painfully noticeable during the last decade. The oil price increases of the 1970's severely affected the industrialized nations and the developing nations. In 1981, the developing nations of the world required about $60 billion a year in new credits to pay for oil imports.[1] The competition between developed and less developed countries for oil to date has not been significant in terms of quantity used by the latter. The cost of the oil used by the developing nations has had a significant impact on their trade balance. Oil imports for many developing countries amount to 50 percent or more of their export earnings.[2] The reliance on oil as the mainstay of energy production world-wide, especially within the industrialized nations, has far reaching economic and social international implications as the price of oil changes. Prime Minister Indira Gandhi suggests that

> We must move from the present international economy primarily dependent on hydrocarbons, to one increasingly based on new and renewable sources of energy. Such a transition is likely to profoundly change international relationships. Instead of the physical transfer of resources, there could be cooperation in harnessing widely dispersed resources with appropriate technologies. With proper sharing of knowledge, developing countries would not need to invest in rapidly obsolescent technologies and the process of transition itself would have a longer lifespan. Such a global outlook does not impinge on the sovereignty of nations, nor is it

incompatible with national policies.[3]

The economic strain of highly priced hydrocarbons severely limits the potential capital of many developing nations to invest into a more secure and stable source of renewable energy. The developing nations of the world need to strengthen their collective self-reliance. Continuous efforts must be maintained to form international institutions that avoid duplication of efforts, wasting precious resources for investment in other energy areas. Technical cooperation and the sharing and exchange of experts and information could vastly improve research and development within the developing countries. A freer flow of technology and sharing of training facilities between the developed and developing countries would require less capital and benefit both, in the short term and even more so in the long term.[4] The interrelationship of oil is almost inseparable from a nation's economic, security, environmental and agricultural well being. Many fertilizers are derived from petroleum. The drastic rise in the price of oil imposed by nations has severely limited the fertilizer imports and chronic food shortages have resulted.[5] The most recent OPEC pricing has dropped the price below $30 per barrel. This is noteworthy as it marks the first price reduction in OPEC's history. Often governments are short sighted and merely manage crises. This new lower price of oil may benefit many of the developing nations to lower trade deficits and encourage investments in renewable sources of

energy. The interdependence of nations is probably most clearly seen in the economic view. A dichotomy presents itself. Almost every consumer would agree that lower oil prices would be beneficial. The World Bank, and many banks from developed nations, have billions of dollars invested in the international oil industries. Lower oil prices may mean that some nations may have difficulty in meeting their debts to the world's banks which would have serious global economic effects. The lower price of oil may delay needed development and implementation of renewable energy sources in those nations whose revenues depend heavily on oil.

The developed nations of the world stand to gain as much, if not more, than the developing and less developed nations by starting now to actively promote and use renewable energy sources. It is the developed nations who depend most heavily on petroleum and fossil fuels for energy needs. Although a continuing search for new oil and gas fields is needed, the encouragement of less developed nations to rely heavily on petroleum could have serious consequences. Forecasts by experts show a bleak picture ahead for the world if present trends continue. The development efforts are in the right direction, but the magnitude is lacking. International Energy Agency studies reveal that fossil fuels could provide 80 percent of the needs of OECD countries by the year 2000, despite present development efforts on renewable energy.[6] Technology must not be relied upon to allow the nations of

the world to ignore the global energy problem until a later date. Many of the problems require long lead times to become productive. These new or renewable energy sources the world needs must also balance with nature and the environment. The destruction of forests for fuelwood or clearing for agriculture by slashing and burning need to be controlled. In many Asian and African states, wood produces a considerable portion of the energy used. ". . . (I)n a hearing before Congress, the U.S. agency of International Development reported that, in 19 countries in Africa, fuel wood makes up more than 80 percent of the total energy consumed in that continent, counting modern energy as well."[7] The ecological imbalances that result from entire forests being denuded are unpredictable. Certainly an emphasis on fuel wood production and conservation is no easy task to coordinate between villages in Africa or Asia. The consequences of failure may be even more difficult to overcome. Nature's unforgiving results could lead to a loss of nutrients for crop production with resulting mass starvation and barren land.

Ideologically, international cooperation is desired by most nations of the world; and specifically toward alleviating the burden on developing countries. Ideology is a necessary part of solving problems that confront us. However, ideology does not always translate into reality once the real economic, political, social, and environmental aspects of a variety of nations are considered. Governments must take the respons-

ibility of moving from the ideal answers to pragmatic implementation. When considering national resources and abilities, impetuous actions by national governments for political prestige and international recognition can often delay needed cooperation. Global cooperation can only truly begin once sound energy policies and commitment by national governments is fostered. Often, this situation takes too long to develop in earnest. Meeting the energy needs of the future can be well planned or delayed and haphazard. The worldwide economic setting must be made favorable for energy investment, exploration and especially production. If cooperation starts now, then a well planned transition from a world highly dependent on oil can begin to utilize a variety of energy alternatives and sources to alleviate the need to do so under severe conditions. The choice of transition is not one of if, but one of when. Policies need to be developed encouraging conservation, efficiency and oil substitution to allow more of the world's potential resources for energy development and production to be utilized. This task will be a great challenge to the developing nations in the process of modernization.[8] Mr. Stanton D. Anderson, speaking at the United Nations Conference on New and Renewable Sources of Energy in Nairobi, summed up cooperation with developing countries as follows:

> (C)ooperation means working together to assist countries in energy assessments to fashion sound national energy policies.

> Cooperation means increased efforts to accelerate exploration and greater utilization of indigenous energy sources.
>
> Cooperation means working with the private sector in both its international and national dimensions.
>
> Cooperation means removing disincentives to foreign investment in energy.
>
> And cooperation means that multilateral resources should complement and catalyze rather than displace flows from the private sector.[9]

The transition to energy independence by nations will not be an easy or quick answer. With diligent effort and cooperation the energy future may be bright. Man's ability to adapt has been called to task before and has prevailed. Humans will solve the energy problem. The question is will it be a solution that allows man the freedom and standard of living he now enjoys?

II. Institutional Cooperation

International cooperation in energy policy is extremely important for the third world nations because their national development and industrialization plans depend on a large amount of commercial use of energy. Bilateral scientific and technical information transfer has flowed from developed to developing nations, but this has not occurred on a large scale. Developing nations, especially non-OPEC developing nations, have urged an expansion of the cooperation at the institutional level.

Among the international institutions which have

dedicated their efforts toward cooperation the Organization for European Cooperation and Development (OECD), the International Energy Agency (IEA), the International Atomic Energy Agency (IAEA), and the United Nations stand out. The work of OECD in this area will be discussed in another paper on this panel. The International Energy Agency is concerned with the benefits for western nations (and Japan) as a response to OPEC and have not emphasized cooperation in the area of development for third world nations. The IAEA, however, has been the primary organization designed to promote cooperation in nuclear development. Since its creation, in 1957, it has made available technical aid in the use of nuclear energy for the generation of electricity in developing nations. A large portion of its activities has been focused on administering safeguards to insure that the developing nations do not divert their nuclear capabilities for offensive military uses.[10] A significant amount of work in the area of cooperation has been done by the United Nations. Numerous organizations within the United Nations System have focused on the need for international cooperation. While the IAEA has already been mentioned, it should be noted that a very large portion of the U.N. organization deals with energy matters. A summary of this activity is found in Table 1, Energy Cooperation Projects of the United Nations System.

A new development for the United Nations was a conference which focused on the needs of all nations. The

Table 1

Energy Ccoperation Projects of the United Nations System

Organization	Source of Energy											Main objective addressed			
	Ocean	Solar	Geothermal	Wind	Hydropower	Biomass	Fuelwood	Oil Shale	Peat	Draught Animal	General	Promote Awareness	Develop Policies	Formulate Programmes	Mobilize Resources
United Nations															
DTCD		x	x	x	x	x		x	x		x	x	x	x	x
DIMSA	x										x	x			
UNCES		x									x			x	
CSTD											x			x	x
ECE		x	x	x	x	x	x				x	x		x	
ESCAP					x	x	x			x	x			x	
ECLA		x										x			
ECA	x	x	x	x	x	x	x	x						x	
ECWA											x			x	
UNCTAD											x			x	x
UNIDO		x		x	x	x	x		x	x	x	x	x	x	x
UNEP	x	x	x	x	x	x	x	x			x	x		x	
UNDP-OPE		x	x	x	x	x	x				x			x	x
Specialized Agencies															
ILO		x			x	x	x				x			x	
FAO		x		x		x	x			x	x	x	x	x	x
UNESCO	x	x	x		x	x	x				x	x	x	x	
WORLD BANK		x			x									x	x
ITU		x												x	
WHO		x		x	x							x		x	
IMCO	x													x	
WIPO				x		x					x			x	
IAEA		x									x	x	x		

[x] indicates that the organization has work relevant to the category in at least one of its proposed subprogrammes or is at least one ongoing extrabudgetary technical co-operation project.

UN, Preparatory Committee for the UNCNRSE, Fourth Session, 8 July, 1981, "Overview of activities relevant to the increased use of new and renewable sources of energy within the United Nations system", Report of the Secretary-General, Addendum.

Table 1
(Continued)
Energy Cooperation Projects of the United Nations System

Organization	Major Issues												Means of Action						
	Rural energy	Conservation and efficient use	Social factors	Energy assessment	Energy planning	Establish R and D institutions	Investment Promotion	Information Collection	Technology Transfer	TCDC	Education and Training	Industrial Utilization	Substantive support to meetings and expert groups	Public Information Services	Technical Publications	Demonstration Projects	Advisory Services	Training	Technical Co-operation
United Nations																			
DTCD	x		x	x	x		x		x	x	x					x	x	x	x
DIMSA	x			x				x				x	x		x				
UNCES	x				x				x		x	x	x	x	x		x		x
CSTD							x	x	x	x									
ECE	x	x	x		x			x					x		x				
ESCAP	x				x			x				x			x				
ECLA															x				
ECA	x	x		x	x	x			x	x	x				x	x	x	x	x
ECWA	x			x	x														
UNCTAD							x		x				x						
UNIDO	x			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
UNEP	x	x		x		x		x	x	x	x		x	x	x	x		x	x
UNDP-OPE	x						x		x	x	x								x
Specialized Agencies																			
ILO	x		x					x	x	x	x	x			x		x	x	
FAO	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
UNESCO	x				x	x		x	x	x	x	x	x	x	x	x	x	x	x
WORLD BANK	x						x		x	x						x			x
ITU	x								x										x
WHO	x	x		x	x		x		x	x	x		x	x	x	x	x	x	x
IMCO								x	x	x	x	x							
WIPO								x		x		x			x		x	x	x
IAEA							x	x		x				x				x	

x indicates that the organization has work relevant to the category in at least one of its proposed subprogrammes or is at least one ongoing extrabudgetary technical co-operation project.
UN, Preparatory Committee for the UNCNRSE, Fourth Session, 8 July, 1981, "Overview of activities relevant to the increased use of new and renewable sources of energy within the United Nations system", Report of the Secretary-General, Addendum.

United Nations Conference on New and Renewable Sources of Energy (UNCNRSE) was held August 10-21, 1981 at Nairobi, Kenya. Many points of view were reflected at the conference including those of the United States, the European Community, and the Group of 77. Later in 1981 the General Assembly passed a resolution on the subject urging, among other things, cooperation among developing countries. Specifically, the resolution urges:

> That developing countries seek to enhance their collective self-reliance in various areas, which are in their mutual interest, through programs of economic and technical cooperation in such areas as exchange of information, joining ventures in project development, joint efforts in research development, demonstration and adaptation of technologies for new and renewable resources of energy, and technical assistance, to supplement the indispensable action to be undertaken by the international community.

Further, it calls on:

> The international community to take measures to provide, as appropriate, support and assistance to the efforts of developing countries to accelerate co-operation among themselves in the field of new and renewable sources of energy . . .[11]

So, cooperation should not only be generated by the developed nations to provide scientific, technical and business expertise, but cooperation should also be among the developing nations themselves. This is especially important because many times the developing nations are more aware of the appropriate technology for other developing nations.

The 1981 UNCNRSE at Nairobi focused on the viability of ten sources of energy (biomass, solar, fuelwood, hydropower, windpower, tarsands and oil shale, ocean thermal energy,

geothermal and peat, and draught animals), examined the limitations of these new and renewable sources of energy, and considered the appropriateness of shifting from the use of fossil fuels to those listed above in the UN - member countries. Participants at the conference recognized the important need for using international institutions to promote cooperation in energy planning.

The success of the conference will be evaluated after a number of years when it can be examined if the programs are implemented. The conference adopted a program of action, known as the Nairobi Plan of Action. The objective of the Nairobi Plan of Action is to "promote concerted action in the context of the energy transition and the development and use of new and renewable sources of energy to help meet future overall energy requirements; especially those in developing countries."[12] This meshes very well with the United Nations' goals of aiming at national, regional and global cooperation. An interesting point is that in the framework for action the Nairobi plan states that responsibility for encouraging energy development in the new and renewable forms of energy lies with individual countries. The plan urges "strengthening national capabilities to conduct NRSE (New and Renewable Sources of Energy) assessments, to establish an NRSE component in national energy policymaking, to support adequate research and development programs both public and private, and to mobilize personnel and financial resources."[13] Governing

bodies, including national parliaments, need to consider these recommendations and take actions, but the decisionmaking processes in the various UN-member nations is often quite slow.

The basic goal of the Nairobi Plan is a fine general statement, but more specific objectives have also been drawn up:

> (1) To strengthen international cooperation for promoting R&D in NRSE technologies and to facilitate the transfer and adaptation of technology from developed to developing countries;
>
> (2) To stimulate mobilization of additional and adequate financial resources from developed states, the multilateral banks, other international organizations and the private sector;
>
> (3) To promote international cooperation for the exchange of information and manpower training;
>
> (4) To promote and provide support for (a) attaining national objectives and priorities established by developing countries in NRSE; and (b) developing and implementing NRSE programs in the context of overall energy plans;
>
> (5) To provide assistance for cooperative efforts among developing countries; and
>
> (6) To specify measures that will heighten awareness internationally of the advantages and potential of NRSE.[14]

The primary value of the conference and the conference's recommendations is that it served to raise the consciousness of developed and developing nations on the matter of renewable energy sources. In addition, it appeared to begin to legitimize the concern for moving away from internatinal dependence on fossil fuels.[15]

While the conference promoted a great deal of optimism,

one can recall that many such conferences and programs of action have not brought positive results. The optimism still remains at this time, but the recent developments in March 1983 have not encouraged adherence to the Nairobi plan. OPEC and non-OPEC oil producing nations reduced the prices of crude oil worldwide and, for those nations who could afford it, promoted a greater level of dependency on imported crude oil. Until the oil importing nations are willing to take major steps in declaring the need to attain self-sufficiency in energy, the national energy plans and the Nairobi plan will not have the impact they deserve.

III. Appropriate Technology

The global overreliance on oil is obvious to the developed as well as the developing countries. Many of today's technologies are not cost-effective when compared to oil. Today's technologies in this jet and space age may, or may not, be cost effective, but as a minimum research and studies on their applicabilities need to be continued. Scientific and technological fixes bring visions of the end of energy shortages. The future remains to be seen. At the present time the answer to our energy needs is appropriate technology. No one technology will be likely to solve our endeavors, but a combination of traditional and modern technologies where appropriate seem a viable option. Many of the developed areas of the world no longer use

traditional sources for a substantial portion of their energy. Prime Minister Indira Gandhi said, "in India animals provide more power than all our powerhouses, whose installed capacity is 29,000 megawatts."[16] The message is that appropriate technology may be an application of new technologies to traditional methods of energy. "The fitting of tyres on traditional bullock carts has made them faster and reduced by more than half the wear and tear of the animal, the cart and the road. Ball bearings on hand-driven grinding stones have mitigated the drudgery of village women. Modifying designs of household implements like stoves, and better architecture for homes and public buildings can make an enormous difference."[17] The central governments of each nation should encourage and actively aid in studies and research on appropriate levels of technology. The wind machines have been in existence for many centuries and provide mechanical or electrical energy. Small wind machines or generators could possibly be used effectively in many regions of the world. Wind data is needed from many of the developing nations before any large scale investments would be wise. There are constraints on wind power; below a certain threshold wind speed no power will be produced. Therefore the energy uses may be limited as a result due to large capital expenditures necessary to store energy. According to Dr. Roger Revelle the power of wind systems varies with the cube of the wind velocity.[18] Research is progressing for wind

energy. In fact, according to the International Energy Agency the research and development of renewable energy sources has grown considerably since 1976, with wind energy making the most progress.[19] In the United States the Department of Energy and NASA are testing a single wind generator capable of producing 2,000,000 watts if the wind blows 25 miles per hour.[20] It may be some time however before generators of this size are cost efficient. In rural sections of developing nations wind machines are needed that are reliable that indigenous labor can build and maintain. The uses of these small wind systems are as varied as the people who use them. Generating electricity, irrigation, and powering small grinders are only a few applications possible. Not all areas of the world are windy enough to make wind systems appropriate.

Biogasification is an energy source that may spark controversy. Although many biogas projects are in use, many people feel bioresearch is needed to increase the efficiency. Some scientists are calling for research to find or develop anaerobic bacteria to produce methane gas. Many naturalists are opposed to bicengineering because of the unknown effects on the environment such development may bring. Presently small biogas plants are available that use agricultural, human and animal wastes. In India the gobar biogas plants, "yield an improved fertilizer plus a clear and efficient fuel, and help to break the devastating cycle of firewood shortage/

deforestation/erosion/loss of fertility."[21] It has been reported that the People's Republic of China installed some seven million biogas plants between 1972 to 1980.[22] Perhaps a useful purpose has been found for ubiquitous plants such as the water hyacinth that has plagued the waterways of the world for years. These plants grow rapidly with little or no care and could be used as waste to power the small biogas plants within villages. The International Energy Agency reports that there are ten biomass conversion projects that will begin test programs in 1983. Their purpose will be to develop technology to use forestry biomass to produce clean fuels, petrochemical substitutes and other energy products.[23] Brazil, a world leader in alcohol fuel production and technology, attained almost thirty percent of its energy in 1977 from wood, charcoal and bagasse (sugar cane residue).[24] "Copesul an affiliate of Brazil's Petrobras and Petroguisa has started up its 480,000 ten year ethylene complex at Triunfo, Rio Grande do Sul, Brazil."[25] Dr. Revelle reports, "In Brazil, annual production of 26 million tons of ethanol from sugar cane is planned by 1990, at which time it is contemplated that alcohol could be substituted completely for gasoline and diesel oil."[26] Brazil is fortunate to have available land for sugar cane that does not have to compete with food crops. Alcohol fuel production from crops is not a viable or appropriate technology for many nations. Another biomass area is concerned with the forests of the world. The

Global 2000 Report predicts that if deforestation continues tropical forests will be approximately 40 percent smaller by the year 2000.[27] Deforestation has many and far reaching consequences. Indirectly, Nepal will lose an estimated 1 million tons of grain annually by 2000 because dung will be burned rather than fuelwood. The dung loss will not be used for fertilizer, therefore the lost grain.[28] Forestry research may aid in this problem that affects several continents. One possible answer is to obtain fast growing trees to use as fuel wood. "The evergreen tropical legume Leucaena leucocephala, is especially well suited to humid and semihumid lowland tropics. In dense plantations in the Philippines, this tall, virtually branchless tree, which can grow to a height of 20 m. in 6 to 8 years, has produced between 12 and more than 50 tons of wood per hectare per year."[29] "Leucaena is able to withstand long dry seasons and to tolerate a wide array of soil conditions, owing to its deep, aggressive root system that reaches far below the soil's surface for water and nutrients. In energy plantations, it could be a continuously renewable source of fuel because the stumps readily regrow or coppice and thus defy the woodcutter."[30] Conservation is often the most cost effective method of preserving energy. Conservation can be applied to almost every use of energy. The problem is one of educating the masses as to the benefits of conserving. It is estimated that clay stoves that could be built by the village people at

almost no cost could quadruple or quintuple the efficiency of burning firewood.[31]

Solar advocates around the world feel strongly that solar power has tremendous potential. The solar industry ranges from flat plate collectors to photovoltaics and solar power towers. Many of the less developed nations of the world are located within the tropics. The more intense and direct the sun's rays are the more efficient is the solar collector. Flat plate collector technology could be cost effective in many remote areas of the world. There are not many moving parts and little maintenance is required. Many proponents of solar power feel certain that mass production and research will continue to lower costs. Certainly the use of indigenous labor and materials would significantly reduce the expense and impact on the host government. Photovoltaics (the changing of light energy into electricity) at present is not cost efficient. Problems still need to be solved to lower the wattage costs. "Paul Maycock, former director of the Department of Energy's photovoltaic program, believes that by 1986 the cost of producing solar cells will be only one-tenth what it is now, making photovoltaics economically feasible for private use."[32] Photovoltaic presently costs about $1 per kilowatt-hour and if the anticipated scientific breakthroughs occur with "amorphous" silicon the effects could be tremendous.[33] The environmental and expected economic benefits of photovoltaics as a source of energy

would have tremendous impacts worldwide, especially on development in less developed nations. Photovoltaics can be used anywhere without the need to be connected to electrical grids. Ideally, it can be used in rural areas and villages around the world. The use of photovoltaics has limits and will not solve the energy problems of the world alone, but through international cooperation and research the development of photovoltaics can become cost effective and benefit the nations of the world. Solar energy has many uses, such as solar cookers, solar drier for crops and even hydropower. Hydropower in many hilly or mountainous regions of the world still has great potential. Micro and mini-hydropower plants are very viable options to increase many countries' national electric grids. Many organizations within the U.N. are presently dealing with development problems of hydropower. Analysis of appropriate site selction, problems of operation and of maintenance of equipment are problems governments will need to resolve.

Nuclear energy development within the developed nations as yet have not proven cost effective over conventional gas or coal fired plants. Probably no other single source of energy is more controversial than nuclear. The feelings run from those who feel nuclear energy is a long term solution to solve the energy needs, to those who feel its proliferation may mean the end of time. Present nuclear technology and operating procedures are being closely scrutinized for safety,

environmental and financial workabilities. Many developing countries construe Article IV of the Non-Proliferation Treaty as an obligation to facilitate the transfer of nuclear power.[34] Nuclear energy is an inappropriate "technical fix" for developing nations because of excess costs, especially capital expenditures. The vast sums of capital resources required for nuclear power are idle for the approximate ten years it takes for construction. This money may be better used as incentives, loans and/or used for construction of other benign energy sources. The insufficient infrastructure in many developing countries would virtually make nuclear alternatives prohibitive for some years. The reason that many developing nations have chosen nuclear power is not necessarily economic, but one more for political purposes and prestige. The total costs of any energy alternative needs to be evaluated fully before tremendous amounts of resources are spent. The cycle for nuclear power is not over after the fuel is used. How do we store the spent nuclear fuel and where? What do we do with the reactors after their useful lives have been spent?

IV. Conclusion

The developing nations which are not OPEC members are numerous, but they consume about ten percent of the world's energy. As their demand for energy has increased they have faced many challenges, including sufficient energy for their

development efforts, acquiring that energy at the lowest cost, with a minimal social impact on their peoples. So many of these poor nations must not only import fuels but also materials required for economic growth. Energy planning for them must be much more cost-effective than for other nations. Each of these nations should consider in its development goals its own natural resources and consider a variety of alternative energy strategies.

A group of non-OPEC developing nations has begun new exploration for oil and gas. More than ten of these nations already export more oil and gas than they consume. Naturally, Mexico will continue to be a major world supplier of crude oil. Yet, so many of these nations have not had a significant level of exploration. The World Bank's recent $4 billion program has allowed a little incentive for hydrocarbon exploration to the poorer of the less developed countries.

The non-OPEC developing countries are often dazzled by nuclear energy, but often the most appropriate technologies for them are non-nuclear. In fact, most of the nuclear reactors are much larger than most developing nations electrical grids can handle. About 40 percent of power is currently generated from hydroelectric power systems. Still, much more hydroelectric possibilities are evident. Other renewable resource systems may provide appropriate answers, such as windmills, pyrolized firewood, and biogas. Small-scale systems are best suited to rural areas in developing

countries where central power systems do not exist on a large scale, and would not be needed. Planning, of course, should be done carefully. Already some ecological problems have arisen, such as deforestation and erosion, in Africa and Asia as a result of poorly planned biomass plantations.[35]

There is a great level of pressure from many areas to increase use of energy in developing nations, including the patterns of growth in industry, urbanization, increases in population, increases in individual incomes, and decline in the availability of traditional fuels, such as wood. The worldwide recession of the early 1980's has modified the demand for energy somewhat. Yet, non-OPEC third world nations have not focused their national energy plans on conservation. Improvements in energy output and efficiency can come from further research, development, and demonstration projects. Research and development assistance to third world nations could be channeled through existing international institutions such as the World Bank and the U.N. Development Program. Some of the developed nations might be more willing to provide such assistance than through bilateral arrangements.

The Resources For The Future study states that non-OPEC developing nations' planning and management will require:

> Improved data on energy consumption patterns, resources, supply, and demand elasticities;
>
> Energy analysts and research centers;
>
> New energy technologies suited to NODC (Non-OPEC developing Countries) needs, resources, climates, and fuel costs; and

Financial and technical assistance from developed countries and international institutions.[36]

There are two basic viewpoints regarding international cooperation in energy policy designed to aid third world nations. One view argues that cooperation between governments and through international institutions has not been very successful because the developed nations are really not interested. They give "lip service" to the notion of cooperation, but are not interested in it because it is not directly financially rewarding for them. The developed nations must be convinced that cooperation is economically beneficial to them before they will seriously be concerned about third world energy development.

A second view says that developed nations are ready to help the third world countries adjust to the new realities of energy needs. They are willing to provide assistance for self-help programs, and not just massive amounts of monetary assistance. Developing countries should provide enhanced investment conditions to attract new investment capital. The example of Far East economic growth coupled with attractive investment incentives showed significant positive results in the 1970's. Regional cooperation could also provide additional benefits for energy development.[37]

Further development of technologies is important, but the application of the technologies to poor, third world nations may be limited. Fission, fusion and many of the complex energy systems not only require sophisticated tech-

nology and further R&D, but they require a great amount of capital. Many oil producing, and non-producing developing nations, will be left far behind as the industrialized nations modernize their energy programs in the next thirty years. The new dependency will be a technological dependency.

The effects of technological dependency are already being felt today. As Jack Barkenbus reports, "the major fission technology suppliers today, the United States, the Federal Republic of Germany, and France, have already imposed a de facto embargo on the export of fuel enrichment and reprocessing technologies (to further nuclear weapon nonproliferation aims). The third world outcry against this policy has been intense but with little effect."[38] Increased moves in the direction of use of non-fossil fuel energy alternatives could mean, according to Barkenbus, "that many third world nations, attempting now to break the shackles of their economic dependency with the major powers, would be dealt a serious setback. This would of course be in addition to their current dependency on increasingly higher priced oil."[39] Although oil prices have dipped in the spring of 1983 one finds that developing nations are still in financial predicaments due to the high price of imported energy.

It has been argued that a major solar program on a global scale will probably not make third world nations significantly less dependent on foreign suppliers and tech-

nology over the next 50 years. Most developing nations have not indicated a great deal of interest in advanced solar technologies. Even with a high level of interest, the costs are significant since

> the high-technology features of solar energy -- that is, solar cells, electrical controls, and heat engines -- will only be manufactured in the technically advanced nations for quite some time. The maintenance and repair of solar devices may not require as sophisticated a technical infrastructure as nuclear energy. Past history indicates, however, that the successful transfer of technology from one society to another does not occur automatically but needs to be carefully integrated within host societies. Not all solar derived energy in the developing world, of course, need be obtained from high technologies. Biogas and biomass technologies could provide rural communities with sufficient quantities of energy. Increased urbanization within the developing nations, however, will mean that these appropriate technologies of today are likely to become increasingly inappropriate in the future.[40]

As has been indicated throughout this paper, development of new and renewable energy sources for developing nations is essential for their long-term future. The appropriate technologies should be deemed "appropriate" by the developing nations and not just by the industrialized nations. However, bilateral and institutional cooperation is imperative. In addition, private assistance, in the form of technology transfer, by private corporations would be very beneficial. All of this costs money. As nations have become more careful with their foreign aid, the question of funding energy development programs must be addressed.

The Nairobi program of action included proposals for

financing. The United States has opposed any new allocation of funds to carry on the program, while the Group of 77 nations have demanded that "additional" and "adequate" funding of development programs called for under UNCNRSE be prepared. The nations of the European community support the Group of 77 notions of financing. But the United States has maintained its stance by saying that it has provided sufficient funds through the U.S. Agency for International Development and through U.S. agencies.[41]

Nonetheless, financing for energy projects has been found. During the period 1975-1980, the U.N. Development Program distributed $91 million for alternative energy development programs, of which 25 percent came from the U.S. Furthermore, the World Bank's energy lending totalled $2.3 billion during 1981. Out of that total, over $1.0 billion (or 40 percent) was used for "policy and planning assistance to developing countries in new and renewable sources of energy"[42] of which "the Bank allocated $750 million for hydroelectric projects and $300 million for biomass energy projects, including fuelwoods. Over the next 5 years the Bank plans to lend about $1 billion for fuelwood projects that would support 1 million hectares (2.47 million acres) of reforestation in more than 50 countries."[43]

The future can be much brighter for developing nations if the institutional approach can be stressed further. And additional financing by the World Bank would be the most

reasonable path to pursue to fund the needed projects in the developing nations. During the current worldwide recession it is not feasible to expect private international banks to fund such loans.

Many questions are still unanswered concerning the energy problem. Perhaps the governments of the world will truly act responsibly to encourage international cooperation, especially the transfer of technology as appropriate for each nation.

NOTES

[1]"International Energy Agency and Global Energy Security Matters," Hearing before the SubCommittee on Energy, Nuclear Proliferation and Government Processes, Committee on Governmental Affairs, U.S. Senate, 97th Congress, 1st Session, July 14, 1981, p. 62. (hereafter cited as I.E.A. Hearing).

[2]"International Energy Development Assistance Programs," Joint Hearing of the Committee on Science and Technology, U.S. House of Representatives, 96th Congress, 2nd Session, March 5, 1980, p. 4. (hereafter cited as IEDAP Joint Hearing).

[3]United Nations Conference on New and Renewable Sources of Energy (UNCNRSE) and U.S. Delegation Participation, Report submitted to the Committee on Foreign Affairs, U.S. House of Representatives, March 29, 1982, p. 28. (hereafter referred to as UNCNRSE).

[4]Ibid.

[5]I.E.A. Hearing, p. 62.

[6]"IEA Sees 7% Return for Two Liquid Coal Products," The Oil and Gas Journal, V 81, January 10, 1983, p. 53. (hereafter referred to as Coal Products).

[7]IEDAP Joint Hearing, p. 59.

[8]UNCNRSE, p. 31.

[9]UNCNRSE, p. 32.

[10]Mason Willrich, et al., Energy and World Politics (New York: The Free Press, 1975), p. 9.

[11]United Nations General Assembly Resolution 36/193: U.N. Conference on New and Renewable Sources of Energy (December 17, 81), Report: A/36/694/Add. 12.

[12]UNCNRSE, p. 10.

[13]UNCNRSE, p. 9.

[14]UNCNRSE, p. 10.

[15]UNCNRSE, p. 13.

[16]UNCNRSE, p. 27.

[17]UNCNRSE, p. 27.

[18]Roger Revelle, "Energy Dilemmas in Asia: The Needs for Research and Development," Science, 209, July 4th, 1980, p. 167. (hereafter referred to as Energy Dilemmas).

[19]Coal Products, p. 53.

[20]James J. Haggerty, Spinoff 1980, (Washington, D.C.: GPO, 1980) p. 10.

[21]Amory B. Lovins and L. Hunter Lovins, Energy/War: Breaking the Nuclear Link, (New York: Harper and Row, 1980), p. 135. (hereafter referred to as Energy/War).

[22]Ibid.

[23]Coal Products, p. 53.

[24]Department of Energy, Office of International Affairs, The Role of Foreign Governments in the Energy Industries (Washington: Department of Energy, 1977), p. 33.

[25]Coal Products, p. 53.

[26]Energy Dilemmas, p. 170.

[27]"International Applications of Renewable Energy Resources," Hearings before the Subcommittee on Energy Conservation and Supply, Committee on Energy and Natural Resources, U.S. Senate, 96th Congress, 2nd Session, August 19 and September 5, 1980, p. 201.

[28]Ibid.

[29]Energy Dilemmas, p. 168.

[30]Energy Dilemmas, p. 168.

[31]Energy/War, p. 134.

[32]Jean Rosenblatt, "Solar Energy's Uneasy Transition," in Editorial Research Reports, Energy Issues: New Directions and Goals, (Washington, D.C.: Congressional Quarterly Inc., 1982), p. 79.

[33]Ibid.

[34]Energy/War, p. 126.

[35]Resources For The Future and Ford Foundation, Energy: The Next Twenty Years (Cambridge, Mass: Ballinger, 1979, pp. 266-267).

[36]Ibid., pp. 267-268.

[37]Otto G. Lambsdorff, "Basic Issues of Energy and Development," The Journal of Energy and Development, VII, 1 (Autumn, 1981), p. 37.

[38]Jack N. Barkenbus, "Energy Interdependence Today and Tomorrow," In Robert M. Lawrence and Martin O. Heisler, eds., International Energy Policy (Lexington, Mass: Lexington Books, 1980), p. 11.

[39]Ibid.

[40]Ibid., pp. 15-16.

[41]UNCNRSE, p. 20.

[42]UNCNRSE, p. 15.

[43]UNCNRSE, p. 15.